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## TEA RESEARCH INSTITUTE

OF CEYLON

Edited by

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THE TEA RESEARCH INSTITUTE.
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The Laboratories of the Institute are situated at St. Coombs Estate, Talawakelle, and letters and enquiries should be addressed to the Director, Tea Research Institute of Ceylon, St. Coombs, Talawakelle. Telegraphic Address:—Research, Talawakelle; Telephone, Talawakelle 44 (Private Exchange). It is particularly requested that letters should not be addressed to officers by name

# EDITORIAL

In view of the shortage of staff and other difficulties, it has proved impossible to publish the usual four numbers of *The Tea Quarterly* in the present year. This issue (Part II) will therefore complete the volume for 1943.

*Fertiliser Supplies.*—Considerable difficulties have arisen in the past few months in regard to fertiliser supplies, particularly in connection with tea manure. In consequence the last quarter's issue of tea manure for 1943 had to be cut 12½ per cent. and was delivered to all estates in the form of the more concentrated mixture T. 460. No cut has had to be made in rubber manure issues, but deliveries to a few estates in the last quarter have been delayed by a temporary shortage of supplies due to delays in fertiliser shipments. The amounts outstanding on this account will be made good immediately further supplies are received. Arrangements for 1944 deliveries, covering the second ration year, will be as follows :—

*Rubber Manure.*—Quotas for the second ration year, 1st January — 31st December, 1944, have been issued to estates. In view of delays in fertiliser shipments, issues will now probably only begin in February but will be completed during the 1st quarter. Quotas have been issued in terms of the standard mixtures R. 400 and R. 215, but the mixture actually issued may have to be varied according to the nature of the manure actually received. Such variations, while affecting the tonnage due to estates, will not, however, change the amount of plant food (nitrogen, phosphoric acid and potash) received by estates which will be according to quota.

*Tea Manure.*—Quotas for 1944 will be issued in January. Practically all supplies from India, are, however, now unavailable and it still remains uncertain whether nitrogenous manures from other sources will be obtainable. Every effort is being made to obtain shipments but considerable delay must inevitably occur before these can reach Ceylon. In these circumstances no issue of tea manure in any form can be made in the first quarter (January-March). Issues will be resumed later if and when shipments are received, but it may not then be possible to make good the arrears due for the first quarter.

If nitrogenous manure cannot be provided an issue will be made of phosphoric acid and potash. Such issues will probably consist of a flat rate allowance for the year of 48 pounds saphos and 8 pounds muriate of potash per acre. The amount received by estates in this case will naturally be too small for distribution in the ordinary way and it is recommended that such manure should chiefly be used in pruned areas to encourage the growth of green manures, the fertiliser being applied in the rows when green manure seeds are sown.

No issue of the phosphoric acid-potash mixture will, however, be made unless and until it becomes certain that nitrogenous manures will not be obtainable.

*Food Production Areas on Estates.*—As stocks of fertilisers beyond those earmarked for rubber are at present not

available, it is regretted the cessation of deliveries in the first quarter will also apply to food production areas on estates with the possible exception of paddy areas. Applications for paddy manure should be addressed to the local A.G.A. (E) and it is hoped limited supplies may be obtainable from this source.

*Distribution.*—This will be continued on the present lines. Estates should note that if manure is offered in any quarter and not then accepted by the estate, the allowance for that quarter will lapse and cannot be delivered in subsequent quarters. Experience in the past year has shewn it is essential to enforce this provision.

Chairmen of District Planters' Associations, District Fertiliser Organisers and Agency Firms will be kept advised of the fertiliser position and, if necessary, announcements will be made in the Press.

ROLAND V. NORRIS.

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# DOES MANURING REDUCE THE DAMAGE CAUSED BY SHOT-HOLE BORER?

C. H. GADD

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E.M.N T.O.

In 1903 Green [2] writing on the control of Shot-hole borer in tea, stated: "Our object should be to induce by suitable pruning and cultivation such a vigorous condition that the damage is automatically and continuously repaired." That statement still fairly represents prevailing opinion today. The aim of every planter is to induce and maintain a vigorous condition in his tea bushes, if for no other reason than that the size of his crop largely depends upon his success in that direction; careful pruning and good cultivation are amongst the methods employed. As an agricultural policy Green's advice is eminently sound. The advice, however, was not given merely as a general agricultural policy but as a specific method of reducing the damage caused by shot-hole borer. If the damage is automatically and continuously repaired by bushes in a vigorous condition, it should follow that visible damage will be least in those areas where the bushes' vigour is greatest, and *vice versa*. The experiment to be described is designed to test that inference, which for so long, has been generally accepted without proof.

It will be obvious that if vigour and damage are to be compared, methods for measuring each must be devised. Vigour will be reflected in yield; the more vigorous bushes may be expected to give the greatest harvest, if other factors, like type of plucking, are kept constant. The crop harvested from individual plots can be determined with considerable accuracy, and such figures may be accepted as a fair measure of bush vigour, or of soil fertility inducing vigour.

TABLE 1.

Experimental Results.

| Treatment | Yield lb. | Broken branches in hundreds | Galleries per 100 broken branches | Healed galleries % |
|---|---|---|---|---|
| O | 432·28 | 63·51 | 176·7 | 20·21 |
| N | 527·41 | 79·84 | 180·6 | 16·78 |
| P | 448·82 | 66·72 | 186·9 | 19·12 |
| NP | 500·20 | 84·08 | 200·9 | 23·68 |
| K | 540·28 | 86·67 | 204·8 | 18·36 |
| NK | 503·60 | 74·32 | 179·0 | 17·55 |
| PK | 415·56 | 65·15 | 190·4 | 16·41 |
| NPK | 483·37 | 72·11 | 181·8 | 19·06 |
| Total | 3,851·52 | 592·40 | 1,501·1 | — |
| Mean | 481·44 | 74·05 | 187·6 | 18·90 |

The primary damage caused by shot-hole borer is the formation of galleries in the stems. If that were all, the boring beetle could be regarded as a minor pest, but unfortunately, the damage does not end with the boring of galleries. The presence of galleries weakens the stems and they tend to break in high winds and during plucking; the fracture always occurs at a gallery. The loss of leaf-bearing branches must cause a loss of crop; that is probably the greatest damage resulting from shot-hole borer attacks. It is not the only damage as, during pruning, branches are apt to break at unexpected places, and after pruning, diebacks are likely to be prevalent because of injury to buds. Also, there are grounds for suspicion that wood rot is increased in the frame following the boring by beetles. Nevertheless, the breakage of branches is the principal damage occurring during the plucking season, so a count of the number of broken branches affords a fair measure of the damage from borer attack. In this experiment the number of broken branches is used as a measure of the damage done.

In previous work [3][4][5] Jepson attempted to determine the effect of manuring on the incidence and control of shot-hole borer. In that work no account was taken of the yields obtained from the experimental plots, nor was any direct measure made of the damage done. Galleries were counted and classified; estimates were made of the beetle population in every plot, and conclusions were drawn from such observations. In this

experiment, the angle of approach to the problem is entirely different, and although observations similar to those made by Jepson were taken, they are regarded as of secondary importance. The measure of bush vigour is yield, and that of damage is the number of broken branches. The problem is to determine how improved vigour, *i.e.*, increased yield, affects the amount of damage as measured by the number of broken branches.

The experiment was designed and laid out by Dr. T. Eden with the object of determining the effect of manurial treatments on the yield of tea in a shot-hole borer infested area of the Passara district, at an elevation of 3,300 feet (approximately) above sea level. It consists of 4 blocks each divided into 8 plots of approximately one-tenth acre in extent. Eight manurial treatments were applied, so that each treatment occurred in every block; the blocks are replicates so far as treatment is concerned. The treatments were (1) no manure, (2) nitrogen alone at the rate of 40 lb. per acre, per annum, (3) potash alone at 40 lb. per acre, (4) phosphate alone at 30 lb. per acre, (5) nitrogen and potash together (6) nitrogen and phosphate, (7) potash and phosphate and (8) a complete mixture of nitrogen, potash and phosphate. Where more than one element was used the quantity of each was the same as that applied alone in treatments (2), (3) and (4). The letters O, N, P, and K. will be used to designate no manure, nitrogen, phosphate and potash treatments respectively in tables and figures.

The plots were pruned on September 2nd, 1940. Plucking started on December 13th, 1940, and was continued at weekly intervals; the crop from each plot was weighed and recorded separately. Manures were applied on March 5th, 1941, and again on April 2nd, 1942. The first collection of broken branches was not made till January 31st, 1942, when 2,689 broken branches were removed from the entire area (3.2 acres). This collection included all branches broken since the plots were pruned. Further collections were made weekly after each plucking when the number from each plot was recorded. Yield and breakage records are being continued during the third year, but the data here discussed refer to the first two years from pruning only, up to and including the records of October 2nd, 1942. Reasons for extending the second year from pruning beyond the correct date, September 2nd, will be given later.

Although the areas selected for the experiment were as uniform as possible, it is certain that all the plots were not equally fertile, *i.e.*, they would not have given exactly equal yields if treated alike. But as eight different treatments were applied, some of which would improve soil fertility more than others, it is not surprising that the crop harvested from the individual plots differs markedly. The highest yield was 171.86 lb. and the lowest 89.88 lb.; other plots gave yields between these extremes. Similarly, the largest number of broken branches collected from any one plot was 2,531; this plot happened also to be the one which gave the highest yield. The smallest number was 1,334 and that was from a plot which gave only 90.15 lb., the lowest but one of all yields. It would be unwise to draw any conclusion from the few data yet given, but they do indicate that if there is any relationship between yield and the number of broken branches, it is *not* the one expected, namely that the smallest number of breakages would be found in most vigorous, highest yielding plots. But there are 32 plot results to be considered.

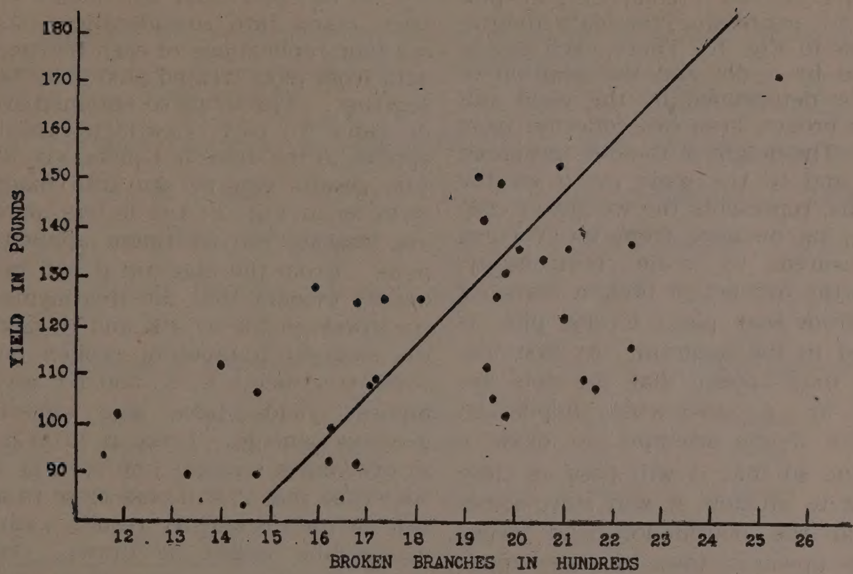


Figure 1.—Showing relationship between yield and number of broken branches in individual plots.

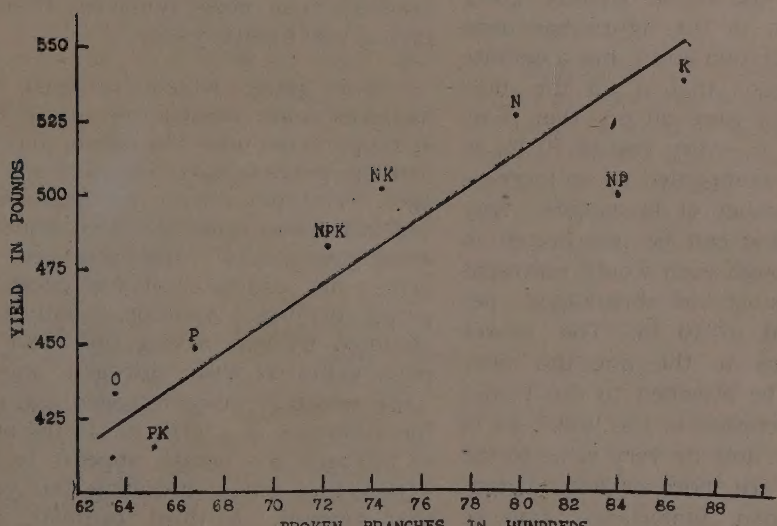


Figure 2.—Showing relationship between yield and breakages, plots being grouped by treatments.

A simple method of comparing all plot results is by expressing the data diagramatically as in Fig. 1. There, each plot is represented by a dot and the position of the dot is determined by the yield and number of broken branches collected from that plot. The height of the dot, measured vertically and to the scale given on the vertical axis, represents the weight of crop harvested ; its distance from the vertical axis, measured to scale horizontally, represents the number of broken branches collected from that plot. Every plot is represented in the diagram. At first inspection it may appear that the dots are scattered in a somewhat haphazard manner, but if one attempts to draw a straight line so that it will pass as close as possible to all dots it will start somewhere near the bottom left-hand corner and slope upwards towards the upper right-hand corner, much as the line given in the figure does. Of course numerous lines can be drawn by eye but they would not all be equally good. The one shown in the figure has been obtained by calculation and it has a definite meaning. It means that if all the dots representing plots were all on that line, not merely near it, every rise of 10 lb. in yield would be accompanied by an increase of 90 in the number of breakages. Any other sloping line can be interpreted in similar terms though each would represent a different number of breakages per increase in yield of 10 lb. The nearer all the dots are to the line the more importance can be attached to the values given by interpretation of the line. As in this instance few dots lie very close to the line and others are more or less distant from it, no great importance can be attached to the values stated above. Nevertheless, the diagram suggests that as the yield increases so does the number of breakages.

So far, particular treatments have not been taken into consideration. As there are four replications of each treatment, the data from plots treated alike may be added together. The totals so obtained are given in Table 1 ; each treatment result now applies to the area of 4 plots, viz. 0.4 acre. The results can be put into diagramatic form as in Fig. 2 ; the letters above each dot indicate the treatment applied to the plots. From the diagram it will be immediately evident that the treatments giving the lowest yields (O, PK and P) have given the smallest number of broken branches, while treatments K, N, and NP giving the highest yields have also suffered the greatest damage. There is little difficulty in drawing a straight line such as the one shown so that it will pass close to all dots. But for the PK and NP results a still better fitting line might be drawn. The line given represents an increase of 180 breaks for every increase of 10 lb. in yield. There can be no doubt from these results that, in general, the larger number of broken branches has been removed from plots giving the higher yields.

The plots which received potash manures alone yielded the largest amount of crop. This does not mean that potash had the greatest *effect* on yield and breakages. The plots with no manure gave 432.28 lb., and those manured with potash alone gave 540.28. The difference, 108 lb., gives one estimate of the effect of the potash manure. Another, equally valid, is obtained by subtracting the yield of the plots manured with nitrogen only from those which received nitrogen and potash ; the difference is $-23.81$ lb. In the presence of nitrogen the potash appears to have a detrimental effect, reducing the yield by that amount. A third estimate can be obtained from the P and PK plots, and again the potash had a detrimental effect, viz. $-33.26$ lb. For a fourth estimate the NP and NPK plots are used and again the

TABLE 2.

**Effect of Nitrogenous, phosphate and potash manures on the yield and damage caused by shot-hole borer**

| | Yields in lb. | | | | Broken Branches | | | |
|---|---|---|---|---|---|---|---|---|
| | With | Without | Increase | % Increase | With | Without | Inerease | % Increase |
| Nitrogen | 2,014·58 | 1836·94 | 177 64 | 9·7 | 31,035 | 28,205 | 2,830 | 10·0 |
| Phosphate | 1,847·95 | 2003·57 | −155·62 | − 7·8 | 28,806 | 30,434 | −1,628 | − 5·3 |
| Potash | 1942·81 | 1908·71 | 34·10 | 1·7 | 29,825 | 29,415 | 410 | 1·4 |

| | Galleries per 400 branches | | | | % Healed Galleries | | |
|---|---|---|---|---|---|---|---|
| | With | Without | Diff. | % Diff. | With | Without | Diff. |
| Nitrogen | 742·3 | 758·8 | − 16·5 | − 2·2 | 19·27 | 18·52 | ·75 |
| Phosphate | 760·0 | 741·1 | 18·9 | 2·6 | 19·57 | 18·22 | 1·35 |
| Potash | 756·0 | 745·1 | 10·9 | 1·5 | 17·84 | 19·95 | − 2·11 |

addition of potash or the presence of nitrogen and phosphate has resulted in a decreased yield, viz. −16.83 lb. Putting these estimates together the total effect of potash is shown to be an increase in yield of only 34.10 lb. It should be noted that all plot results have been used to obtain this value, half of them received potash and the other half did not, so that increase of 34.10 lb. has been obtained from an area of 1.6 acres. The effects of nitrogen and phosphate can be obtained in a similar way. The results affecting yields and breakages are given in Table 2.

Comparisons of the effects of all three manures on yield and breakages are easily made from Table 2, and it is remarkable that whatever effect the manure has on yield, a similar and almost equal effect is observable in the number of breakages. From the table it will be seen that nitrogen, not potash, had the greatest effect in increasing the yield and also in increasing the breakages. These results leave no doubt whatever that the inducement of vigour as measured by yield does *not* lead to a decrease in the damage caused by shot-hole borer. On the contrary, an increase in yield is accompanied by a corresponding increase in the number of breakages.

Obviously, the breaking of branches cannot of itself lead to an increase in crop; it must have the opposite effect. This becomes evident when the size and quantity of the broken branches are considered. All the branches collected on 5 occasions were weighed, and from the results given in Table 3, it will be seen that the mean weight of 100 branches was 5.77 lb. In all, 59,240 branches were collected from the area during the first two years from pruning, which is equivalent to 18,512.5 per acre, weighing 1,068.17 lb. As 6,000 lb. is a fair weight of prunings removed from an acre of tea during normal pruning operations, it becomes evident that approximately 17.8 per cent. of crop-bearing branches have been lost at some time or other during the two years. That loss may have reduced the cropping capacity of the bushes by as much as 8 or 9 per cent. That the breakage

of branches has caused some loss cannot be doubted. It seems strange, therefore, that the plots which lost most branches nevertheless gave the greatest crops.

The manurial treatments which improved soil fertility would cause an increase of the harvest, but what has here been measured as increase in yield due to treatment is not the true increase that would occur in the absence of shot-hole borer, but only what remains of it after the loss from increased borer damage has been deducted. This may well raise questions concerning the economics of manuring in shot-hole borer infested areas, but we shall not concern ourselves with that problem here. Instead, we may attempt to ascertain why manuring should result in an increase of insect injury.

Green appears to have based his recommendation, already quoted, on the fact that in some galleries "The mouth of the tunnel is invaded by an ingrowth from the vigorous cambial tissues. New wood is then formed, covering up the old wound, and the plant is able to carry on all its functions without interruption." Galleries with plugs in their entrances are now known as *healed* galleries, and it is generally understood that healed galleries are less liable to break than are open galleries, *i.e.*, without plugged entrances. The mere presence of a plug in the gallery entrance is unlikely of itself to strengthen materially the branch at that place and so prevent it breaking. Something more than the healing of a visible wound is required.

So long as beetles are in occupation of a gallery they will keep the gallery entrance open if for no other reason than to facilitate emergence; but when a gallery is vacated the callus growth may block the entrance unhindered. For this reason healed galleries must, as a rule, be older than open galleries. So long as a branch is growing, new wood is laid down just within the cambium, outside the circular gallery. This new wood strengthens the branch, and as a healed gallery is older, it would follow, other things being equal, that it has more young wood around it and the branch is in consequence stronger there than at a place where the gallery has been more recently bored. The branch therefore becomes less liable to break at a healed gallery as will be demonstrated later.

At the end of the second year, on September 4th, October 2nd and October 30th, 1942, all the broken branches were removed to the laboratory for detailed examination. The data collected have been amalgamated as though taken at one time, viz. on October 2nd, the mid-date of the three, and as being representative of conditions at that time. For that reason October 2nd was taken to be the end of the second year though one month late. The results of these examinations are given in Table 1.

In all, 4,727 galleries, inclusive of those at the break were examined, and 897, *i.e.*, 19 per cent. of them were healed. If every gallery were equally liable to break we should expect about 19 per cent. of the galleries at the fractures also to be healed. Actually, there were 2,510 broken branches, but only 156 or 6.2 per cent. had broken at healed galleries. The observed number of healed galleries at the factures is much smaller than was expected if healed and open galleries are equally liable to break, so it becomes obvious that healed galleries are less liable to break than are open galleries. It would, however, be better to state the same fact in other words, namely, that the risk of a branch breaking at a shot-hole borer gallery decreases as the age of the gallery increases.

The rate of decrease in the risk of breakage will depend, at least in part, upon the rate at which new wood is being formed. It has been assumed, perhaps rightly that

TABLE 3

Number and Weight of Broken Branches

| Collection | Date 1942 | Branches No. | Weight lb. | Weight per 100 in lb. |
|---|---|---|---|---|
| 1 | January 31 | 2,689 | 169·78 | 6·31 |
| 2 | February 7 | 1,183 | 81·51 | 6·89 |
| 17 | May 22 | 1,722 | 90·74 | 5·27 |
| 32 | September 4 | 1,162 | 52·66 | 4·53 |
| 36 | October 2 | 643 | 31·92 | 4·96 |
| Total Data | | 7,399 | 426·61 | 5·77 |

the more vigorous a bush is, the more rapidly will new wood be formed and the risk of breakage be decreased. There appears therefore good logical grounds for Green's recommendation that the best way of decreasing damage by shot-hole borer is by improving the vigour of the bushes. Nevertheless, the results of this experiment suggest that there must be a fallacy in the argument somewhere.

What assumptions have been made, though unstated, in the argument? First, it is assumed that an improvement in the vigour of bushes will not make them more or less attractive to the beetle. If the bushes become more attractive, more galleries are made and the stems have more weak places in them. Increased damage would not then be surprising. Second, there is the assumption the wood laid down by a vigorous bush will be equally strong as that laid down more slowly by less vigorous specimens. If it is not, the greater number of breakages would occur in those plots with the weaker wood when the number of galleries is the same in all plots. The observed results of this experiment could be explained (1) if the manurial treatment resulted in an increased attack by the beetles or (2) if some treatments made the branches more fragile.

We are now confronted with the questions (1) Were there more borer galleries in some plots than in others? and (2) Were the branches in some plots more fragile than in others? Neither of these questions can be answered with any certainty.

To count all the galleries in the experimental plots would be an impossible task. Jepson counted the galleries, *in situ*, of a number of bushes selected at random—an arduous task and one liable to considerable error. Another method [1] is to prune the selected bushes and count the galleries in the prunings. This has the advantage of increased accuracy as the presence of every gallery can be proved, but it has an obvious disadvantage in that it cannot be used in plots from which accurate yield figures are required. In this experiment, broken branches only

were examined on three occasions as already stated, and the galleries in them counted and classified.

A moment's consideration will show that the largest number of galleries is most likely to be found in the branches from the plot with most breakages, not because the galleries are most numerous in that plot but because there are more broken branches to search. This can be corrected by expressing the number of galleries as the number per 100 branches, as shown in Table 1. If such estimates are accepted as a fair measure of the number of galleries in each plot, it must be borne in mind when making comparisons, that all plots have the same number of branches per bush is assumed and nothing is known of the galleries in unbroken branches.

To facilitate comparisons, the effects of the manures on gallery numbers have been calculated in the same manner as for their effects on yield and breakages. The results are shown in Table 2 from which may be seen that the effects are very small, almost negligible, and the values show no obvious relationship to yields. We certainly cannot attribute the increased number of breakages in the higher yielding plots to an increased number of galleries in their branches. There may be markedly more galleries in some plots than others, but if so, this method of estimation does not detect the differences.

The fragility of branches, *i.e.*, their tendency to break, is also difficult to estimate directly. The percentage of galleries that have healed can be determined fairly accurately; the estimate does not depend upon the number of branches used but upon the total galleries counted. It has been assumed that the percentage of healed galleries affords a measure of the rate of healing—the higher the percentage, the faster the galleries must be healing. As healed galleries are less liable to break than galleries with open entrances it should follow that by speeding up the healing process fewer breakages should result.

The percentages of healed galleries in the different plots have been examined to determine to what extent the manures have speeded up healing. The effect of manuring with nitrogen has been to increase the percentage of healing by less than one per cent., though its effect on breakages was to increase the number of broken branches by nearly 10 per cent. There is obviously no relationship between the number of fractured branches and the rate of healing or growth as measured by the percentage of galleries healed as may be seen from Table 2.

The results of the experiment may now be briefly summarised. The results show that the greatest number of broken branches are found in the plots giving the highest yields. Nitrogen caused the greatest increase in yield; it also caused the greatest increase in insect damage. These results are clear and beyond doubt. No satisfactory explanation however can be offered as to the way in which yield and breakages are linked together. The results are in conflict with prevailing opinion, but so far as the writer is aware, they are the first published records of yield and breakages resulting from shot-hole borer attack in comparable plots. Admittedly, confirmation is required from other experiments. This experiment is being continued during its third year from pruning and it is hoped that the results will throw further light on the problem.

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# LENGTH OF PRUNING CYCLES UNDER PRESENT CONDITIONS

T. EDEN

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The last issue of *The Tea Quarterly* ontained an article dealing with the ength of pruning cycles relative to pluck-ng costs and labour shortage. Since then ve have received a number of enquiries bout the wider question of the effect of essation of manuring on length of cycles. ince one of the enquiries put the issues o clearly and was quite typical of the rest ve print for general information the etter of enquiry and the Agricultural hemist's reply.

## QUESTION

"I find it difficult to reconcile the oft nade statement that this field or that field ıust have not less than 40 or 55 lb. nitro-en, if it is to be economically cropped, vith the current statement that now hat fertilisers are so greatly reduced (if not cut out completely), the pruning cycle of that field or this must be reduced.

"I therefore seek enlightenment, and so that you can put my erring reasoning right, — here it is.

"Cropping of the tea tree is an unnatural process, and an exhausting one. To counteract that (apart from considerations of maximum profits) we fertilise it with chemicals. (We also pay attention to soil texture, but that does not enter into the argument). In fact, we foster it to counteract our own somewhat brutal treatment. When it refuses to yield any further economical flush, we prune it, — another most unnatural operation, which is designed to stimulate new leaf growth. Consciously or unconsciously we are aiming at forming a frame to carry the leaf

growth which means *£.s.d.* There is also a reverse action whereby the area of leaf decides the degree of frame-forming, and provided we don't strip, I believe the branch girth increase accelerates as the age from pruning increases.

Apart from cultivation, the chief factors which decide the length of the pruning cycle are jat and elevation. If, under normal cultivation, we prune a field 36-monthly and decide, in view of the absence of a fertiliser, to prune it at the end of 30 months, we will be pruning immature branches, and a continuance of the process will lead to a progressive decrease in branch girth and probably to a progressive decrease in economical flushing life. We remove the natural stimulant of a fertiliser and apply, all the earlier, the unnatural and shocking stimulant of the pruning knife. Sure two wrongs, in this case, don't make a right ?

"My own opinion is that the proper thing to do is to leave the pruning cycle unaltered and to rest the tea when it ceases to yield an economic flush. Taking the case above, I would rest the field its last six months, say, and then prune it to schedule. Over the first two cycles I believe the yield of the field under an accelerated 30-month cycle might be very slightly better than of the 36-monthly one, with six months of rest each cycle. Extended to a period of, say, 15 years, which would be five and six cycles for the two methods I believe the 36-month field would show a very superior yield over the other, — both without manure, of course.

"Even in the early stages I do not believe the advantage in favour of the 30-month treatment would be more than slight, and I doubt whether tea is such an urgent necessity to warrant perhaps permanent damage to our bushes. We will need tea after the War to trade with Russia and to maintain the revenue of the Island should rubber slump. A further consideration is that to alter pruning cycles now may seriously disorganise estate routine, with a general shortage of labour obtaining at present."

### REPLY

"I do not think there is anything irreconcilable in the conceptions outlined in your first paragraph. The explanation is rather long and perhaps a little involved, but here it is.

"The natural growth cycle starts with a vegetative phase and gradually passes over into a reproductive one producing less leaf and a preponderance of flower and fruit. Studies have been made on fruit trees and these show that this change is accompanied by a change in the relative proportions of carbohydrate and nitrogen in the tissues of the plant ; as the cycle progresses the ratio Carbohydrate/Nitrogen increases. The carbohydrate comes from the photosynthesis of carbon dioxide from the air and we have no means of altering those conditions. But by supplying nitrogen to the plant we can in fact delay the time at which a tree ceases to lay down foliage buds and produces instead flower buds. You may know that a common method of bringing an over-luxuriant fruit tree into bearing is by root pruning. This is the reverse operation and is designed to restrict the assimilation of nitrogen. It follows that a restriction in nitrogen, such as is at present inevitable, will tend to accelerate the time at which the reproductive phase becomes dominant and thus will reduce the cropping status of the latter part of the pruning cycle.

"Whatever interference with the process just outlined may be attempted by normal nitrogenous manuring, the time does inevitably arrive when the vegetative phase wanes in activity. We then prune the

bush in order to deprive it of the potential flowering buds which are laid down long before they become evident in mature flowers and seed. These buds are present in the younger tissues, not on the old wood. The plant is thus forced once more into the vegetative phase. You may describe this, if you like, as an unnatural process but up-country at any rate it is not an exhausting one.

"There is no point in merely resting a run out field at *high elevations*, for all you will succeed in doing is to improve the carbohydrate status of your bush, which is not desired. In this connection I have recently obtained results which show that at this elevation even when bushes are plucked to the fish leaf from tipping time onwards, there is no evidence at the end of 3 years that carbohydrate storage is depleted in comparison with that shown by bushes normally plucked carrying a much greater bulk of foliage leaf.

"As regards the building up of frames for bushes, I dissent from your idea that branch girth *accelerates* as age from pruning increases. Perhaps you mean that it goes on increasing but not necessarily at a greater rate. I have data to show that the production of wood (measured by weight of prunings) is closely correlated with foliage production, but I cannot say that the ratio of wood to leaf in a four-year cycle, for example, is higher than in a three-year one. In any event, the production of wood in the shorter cycle is affected by the fact that less severe pruning is required, since on such cycles the bush height is not so liable to get out of control.

"Moreover by shortening the pruning cycle under present conditions one makes plucking easier and cheaper, which is a consideration these days. As an illustration of how difficulty in the plucking of long pruning cycles can affect yields, I may cite a comparison between the behaviour of an experimental area in a four-year field, and the behaviour of the field as a whole. During the first two years the part and the whole gave almost identical yields per acre. In the third and fourth years, whilst the experimental area increased steadily in yield, the rest of the field showed diminishing yields, although from the comparison in earlier years this fall would not have been expected. I am naturally able, on an experiment, to secure a measure of supervision not attainable on an estate as a whole, and I attribute the loss of yield on the rest of the field to the less stringent standards of plucking attained.

"I have examined quite a number of estate records with a view to ascertaining whether the long cycle pays in crop. The method is simple. If a fourth year is to pay, it must give at least the average of the previous three. It is remarkable how frequently this fact is overlooked on estates.

"In general therefore, I think the policy of reduction in pruning cycles is inevitable at present if crop yields are to be maintained, and I do not think the general vigour of the tea will be affected."

# TEA WEEDING*

E. C. MARSH-SMITH

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There appears to have been an interesting discussion on this subject at the P. A. General Committee Meeting in Kandy in September. Possibly, therefore, the experiences of someone who has tried selective weeding for more than twelve years may be of interest.

It had struck the writer that in the large amount of weed growth available there must be two natural advantages viz.

Prevention of soil erosion,

Addition to the humus content of the soil.

It happened that on this estate in 1929 a sudden outbreak of Lime Weed (*Polygonum nepalense*) occurred in one block of 7 acres. This came on so suddenly that in a matter of 6 weeks a complete cover obtained and the oxalis was stunted and all other weeds were temporarily obliterated. On examination it was found this weed had some very useful features. They were as follows :—

The root system existed only on the surface to a depth of an inch, many plants actually existing on the dead tea leaves and not in the soil below.

Secondly, the rate of growth was such that other weeds were choked out or as in the case of 'white weed' (*Ageratum conyzoides*) they had to come up to a height of 15 or more inches before they could flower, thus resulting in easier eradication and greater weight of weed spoil.

Thirdly, the Lime Weed cycle of life is short, varying from a few weeks to three months. A small drought at flowering time or beating down by weeders caused an immediate wilting away resulting in a thick cover of decaying vegetable matter.

Fourthly, the quick cycle allowed Oxalis to come back rapidly thus causing cycles of each and a fairly constant ground cover.

Fifthly, there appeared to be no deleterious effect on the tea after a year or more of observation. In fact this small block improved considerably, as it had previously suffered from erosion and the effects of drought.

By 1931 Lime Weed was established in further areas, so that when in 1932, and more particularly in 1933, a drastic curtailment of weeding costs was necessary it was possible to allow Lime Weed to spread at once throughout the estate.

Other conditions obtaining were the fact that grasses and white weed seemed to come in cycles, and the planting of paspalum grass verges on all road edges and banks gave shelter to bamboo grass. It was found this bamboo grass seeded in April-July and by September many areas were infested with sprouting grass particularly under the bushes. It became more than ever essential to have a cover to stop bamboo grass spreading.

The other weed was "Spanish Needle" (*Bidens chinensis*) known as 'Usi Pillu.' This also occurred mainly in dry months

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and in open areas such as vacancies and poria plots.

The average elevation of the estate is 4,400 feet; there is much rock in some areas and there are no flat places of more than a few square yards. A primary need was therefore to guard against erosion. Evidence of many years of scraping were easily to be found. All drains and silt pits were put into good order and terracing commenced on eroded areas. The next problem was to evolve the technique of what is called selective weeding with the object of keeping down costs and if possible making a reduction, preventing erosion and finally getting some return — increased humus. For the time being it was not necessary to press for crop as Restriction had arrived. Thus in a way it has been impossible to draw any clear conclusions as to the effect of weeds on crop. Further there was a change in pruning policy. However, it has been found possible to extend the pruning cycle by several months, and the tea almost throughout the year maintains a good colour. Only under exceptional weather conditions have areas been noticeably 'run out' before pruning, and then only in small blocks. Artificial manure has been short averaging under 20 lb. Nitrogen per acre over 15 years.

However, some results are definite as follows :—

1. There is now no wash over 90 per cent of the estate. Where it does occur the faces are so steep as to prohibit the extension of the ground cover, or terracing. Wash inevitably also occurs where concentrations of water fall from large rocks. or where road banks have not yet been protected.

2. There is definitely an improvement in the surface soil in texture and depth.

3. Value is given to leaf-fall from shade trees and the tea by the ground cover holding it up.

4. An immense amount of weed spoil is rotted down under a very simple system giving over 1,000 tons a year. A large amount of Indore Compost apparently is not suitable for tea, and supplies in particular, but this weed spoil can be put out anywhere at any time, even in large quantities.

5. Costs have been reduced compared with the old clean weeding without reckoning any advantages from Item No. 4.

6. The spread of *Drymaria* is kept in check. Though deleterious effects on tea cannot be ascribed to *Drymaria,* it definitely hinders weeders in search of grass and it tends to climb into the tea. It does, however, hold up leaf-fall and gives a thick mat of decaying material when it dies back.

To come back now to the system employed, it was first necessary to overcome the labourers' dislike of pulling out weeds, to prevent scraping as much as possible, to use the point of the scraper and not the side, to prevent the trick of covering weeds in drains by cutting down banks, and finally to teach them that ground covers in the end make weeding easier during most months of the year. It is necessary to repeat all this tens of thousands of times before it makes any impression. Determined persistence alone will bring any results.

It was reckoned that roughly one collecting centre per 2 acres was required to build up 'Composting' heaps sufficiently rapidly, but this would vary with the prevalent weed and type of land, etc. It is better to have these collecting sites cut into road banks or where roads cross

ravines. They must be handy or weeders won't bring the weeds. They must be large enough to collect all the weeds and allow the 'Compost' men to work on the heaps, cutting, ferning, etc. About $6 \times 12$ feet is ample as a rule. If there are too many sites it will take a long time to collect enough weeds to build up a 'loaf' of them to start the breaking down process.

With adequate supervision 2 or 3 men, according to the weed season, are ample to do a round a month working only, say, 10 to 12 days actually on collecting and heaping over 200 to 250 acres. They should have mamoties, baskets and sacks, otherwise weeds will be dropped all along the roads, and it is extremely dangerous to allow pieces of cootch and 'Ammalai pillu' (*Commelina nudeflora)* to be dropped. These men after collecting proceed to press the weeds into a 'loaf' say $4 \times 2$ feet or according to weeds available. After every 4 to 6 weeks these heaps are chopped up and rebuilt until it is considered they are broken down sufficiently to use as spoil. The condition usually reached in 4 months or so is a blackish, crumbly soil and this is put out when required at, say, one basketful to every group of 4 bushes. A cubic foot would weigh about 20 to 30 lb. according to the moisture. In dry weather sometimes additional water must be used on the heaps. Any grasses, ferns and leaves can also be heaped with the weeds and rotted down. Lime, if available, is useful to help break down the weeds. With a few pounds of cattle manure added. this weed spoil is a splendid filler for bringing on Dadap cuttings. When the spoil is put out for tea some demarcation of the areas should be made so that gradually a large area is supplied. In this way over a period of two years large backward areas can be treated.

Regarding costs these can be deduced from the number of men required monthly as stated above. To this must be added cost of baskets, sacks, etc. and any extra coolies needed for lime and cattle additions. The first year will be more expensive till the method is understood, say, Re. 1 per acre per annum and later it should not exceed 75 cents per annum. Weeders, however, must be made to do the bulk of the collecting in small heaps along roads and on convenient rocks and ravines, etc.

The appended costs (on next page) per annum to the nearest rupee will show that the inauguration of 'selective weeding' has caused a big saving as these figures can be multiplied by many hundreds of acres. The check-roll rate in 1928 was actually higher than now but contract rates have not varied very considerably, except in 1933 when full selective weeding was started and rates were cut very much due to the slump. In 1942 very bad weeds were experienced and rates increased.

Finally, very many other weeds were tried at different times, but none has fulfilled the requirements even to a small degree compared with Oxalis, Lime Weed and *Drymaria,* these being in order of preference. It must be understood though that Oxalis gives practically no additions to the weed heaps compared with the latter two kinds.

The matter of forking in weeds is another large subject, really cultivation, and cannot be dealt with here. But whatever such policy was it would be negatived to a great extent with the present shortage of labour, if any particular programme fell through and fields were neglected. What is cheaper in the long run and will help in the weed control question is leaf-fall. This is also a subject which cannot be dealt with here, but unless lopping of Albizzias and Dadaps is reduced many estates will find little advantage from having merely weeds by themselves. High shade apart from giving constant leaf-fall protects the tea against wind and rainbeat.

Cost of Annual Weeding Per Acre

| Year | Rupees per Acre | Year | Rupees per Acre |
|---|---|---|---|
| 1926 | 35·00 | 1935 | 21·00 |
| 1927 | 31·00 | 1936 | 22·00 |
| 1928 | 33·00 | 1937 | 20·00 |
| 1929 | 43·00 | 1938 | 21·00 |
| 1930 | 35·00 | 1939 | 20 00 |
| 1931 | 33·00 | 1940 | 20·00 |
| 1932 | 30·00 | 1941 | 24·00 |
| 1933 | 16·00 (Slump rates) | 1932 | 26·00 |
| 1934 | 20 00 | 1943 ($\frac{3}{4}$ Year) | 19·00 |

# SOME NOTES ON THE SELECTION OF HIGH-YIELDERS ON DOOMBAGASTALAWA ESTATE, KOTMALE*

C. E. V. RYAN

Selection work was commenced on Doombagastalawa Estate, Kotmale, towards the end of 1940, and is still in progress. The first step was to decide upon the type of bush which appeared to do best on the estate and then to take steps to pick out all those bushes which conformed to this type. Such selection is essentially visual in its nature, and was carried out in the following manner :—

Preliminary selection was made by the pruners at the time of pruning. Each pruner was told to leave 10 to 15 of the largest bushes in his row in each day's task. It was explained to them that these bushes must

(a) be of good jat.

(b) be not on the sides of roads, or drains, or bordering the boundaries of the field.

(c) be not adjacent to vacancies, or young supplies, or on spoil earth, and must be neighboured on all sides by vigorous bushes,

(d) be single, and not compound bushes.

* The Institute does not necessarily endorse the views expressed in papers contributed by persons not members of the Institute's Staff.

These conditions were laid down with the object of eliminating, as far as possible, the possibility that the bushes finally selected for propagation would owe their capabilities entirely to a favourable environment. This is of the greatest importance, for the characteristics it is desired to reproduce must be inherent in the mother-tree itself and not derived by it from any outside influence, such as an advantageous location.

The bushes so selected were then marked with numbered metal plates. When the prunings in the field had dried, the bushes left unpruned stood out clearly, and an individual visual examination of these was made. Those which appeared to be below standard, or which did not satisfy *all* the above conditions, were pruned down and discarded. The bushes left appeared to the eye to possess much the same characteristics relative to one another, but as it was difficult to carry out a visual comparison between widely separated bushes, it was felt that some further criterion than mere observation was necessary if a greater degree of uniformity were to be achieved in the bushes selected. Having then, rejected those bushes which were *obviously* below the standard required, the circumferences of the remainder were measured, their average ascertained, and those below this average rejected.

It is doubtful whether rejection on such grounds was wise. It is difficult to measure the circumference of a tea bush with any degree of accuracy, for it might vary considerably with even slight differences in the height above the ground at which the measurement is taken, and also with slight differences in the tension applied to the tape. It is possible, therefore, that a number of potential high yielders were rejected because thir measurements were undertaken somewhat haphazardly.

Further eliminations were carried out at the time of tipping, the primary branches being counted over three tippings and rejections being made of those below the average in this respect. The idea was based on the assumption that the yields of bushes vary directly with the number of primary branches in the bushes. Such an assumption is probably not true, and this reason alone would be sufficient to render the test valueless. Besides, it is probable that many subsidiary shoots were counted as primary branches at the second and third tipping, whilst many bushes undoubtedly formed primary branches much later than others, and after the third tipping.

The selection and rejection of bushes by the above methods will no doubt be considered by many to be a mistake in view of the fact that a number of potential high-yielders were probably lost. On the other hand, those retained did survive a series of rigorous tests. They were remarkably uniform in appearance, and that, after all, was the object aimed at — uniformity of type. Inherent and invisible characteristics could be determined later under more searching tests. It must be remembered that the average superintendent has not the time, labour, or factory accommodation to carry out prolonged yield tests on thousands of bushes. He has, therefore, to be absolutely ruthless in his early rejections, selecting for actual yield tests only perhaps a few hundreds of his very best bushes every year. Indeed, ruthlessness in early rejections is the very essence of selection work, and the loss of at least some potentially good material is practically unavoidable, whatever methods are adopted.

Subsequent to the above, some preliminary selection was carried out by pluckers in other fields, just before pruning those fields. The same conditions regarding location, etc. as laid down for pruners, were adhered to and, in addition, it was

stipulated that the bushes must be in vigorous flush. The idea behind this last condition was to select bushes which were obviously staying the full course of three or four-year pruning cycles, and not those which, though possessing all other desirable characteristics, were "bad stayers." Eliminations were made solely on the basis of yield over eight regular weekly plucking rounds.

The objection to this method is the difficulty of making visual comparisons for differences in external characteristics, for it is not easy to do this while all the other bushes in the field are in leaf. However, this is not a serious difficulty for after preliminary rejections have been made on a yield basis, the remainder can be subjected to visual examination after the rest of the field has been pruned, and prior to more prolonged tests for yield after pruning. A further difficulty is the one of supervision. A large gang of pluckers is liable to leave out potential high-yielders, while a small gang of pruners is more easily checked in this respect.

Having, by these methods, made a preliminary selection for uniform type, the bushes selected were subjected to actual yield tests.

Linen weighing bags 18 × 7 inches with two tapes, one at the top and one at the centre, were obtained from the Wellawatte Spinning and Weaving Mills. On these bags were stencilled red numbers to correspond with the number of the field in which they were to be used, and black numbers to correspond with the selected and numbered bushes in that field.

After the third tipping, each selected bush was plucked at regular weekly intervals. The bags were tied by the centre tape and the leaf from each bush was put into the top half of the bag, the number on which corresponded with the number on the bush. The bags were then tied at the top and sent to the factory. This process was continued for 8 regular weekly pluckings. Before each pluck, after the first, the centre tapes of the bags were untied so that the leaf from the previous pluck fell to the lower half of each bag, which was then retied at the centre before commencing the new pluck.

On arrival at the factory, the bags were hung near the drier, the prior permission of the Insurance Co. having been obtained without any difficulty. At the end of the 9th week, *i.e.*, a week after the 8th pluck, the bags were put into the drier where, without rotating the trays, they were dried for about two hours at a temperature of 180 degrees F. to a moisture content in the tea of between 4 per cent and 6 per cent. The fired leaf in the bags was then weighed, on an ordinary letter balance, to the nearest ¼-oz. and the yield of each bush recorded. This procedure was repeated over 48 regular weekly pluckings, *i.e.*, for 6 plucking periods of 8 plucks each. Rejections were made on the yield basis at the end of every 8 plucks as follows — 50 per cent at the end of the 8th pluck, 25 per cent at the end of the 16th pluck, 10 per cent at the end of the 24th, 32nd, 40th, and 48th plucks.

The table (page 48) gives the results in respect of the bushes finally selected in one field — the results being similarly tabulated in respect of each of the other fields.

At the head of each column are the plucking rounds, below which are indicated the moisture contents. The total moisture content is taken as the mean of the moisture contents for the 6 plucking periods. The figures in the columns proper are the weights in ozs. The bracketed figures represent the order of merit at each pluck, within the limits of the bushes finally selected for consideration.

Consideration must now be given to these figures with the object of selecting from them those bushes from which it is desired to propagate. It is not intended to lay down hard and fast rules as to how such final selection should be made. This will depend upon such factors as the nursery space available, the land available for the establishment of clones, and so on. A few guiding principles may, however, be laid down.

| Bush No. | 1/8 5·75% | 9/16 5·00% | 17/24 4·50% | 25/32 4·75% | 33/40 5·00% | 41/48 4·25% | Total 4·88% |
|---|---|---|---|---|---|---|---|
| 1 | 4·50 (2) | 4·00 (1) | 4·25 (1) | 6·00 (1) | 6·25 (1) | 5·25 (7) | 30·25 (1) |
| 3 | 5·50 (1) | 3·50 (2) | 4·00 (3) | 5·75 (2) | 5·75 (3) | 5·75 (2) | 30·25 (1) |
| 32 | 4·00 (4) | 3·25 (3) | 4·25 (1) | 5·25 (4) | 5·50 (6) | 6·00 (1) | 25·28 (3) |
| 33 | 3·75 (7) | 3·00 (5) | 4·00 (3) | 5·75 (2) | 5·75 (3) | 5·50 (4) | 27·75 (4) |
| 24 | 4·50 (2) | 3·25 (3) | 3·50 (9) | 5·00 (6) | 5·75 (3) | 5·25 (7) | 27·25 (5) |
| 198 | 4·00 (4) | 3·00 (5) | 3·75 (5) | 5·00 (6) | 6·00 (2) | 5·50 (4) | 27·25 (5) |
| 4 | 4·00 (4) | 2·00 (11) | 3·75 (5) | 5·25 (4) | 5·25 (8) | 5·25 (7) | 25·50 (7) |
| 7 | 3·50 (9) | 3·00 (5) | 3·75 (5) | 5·00 (6) | 5·00 (10) | 5·00 (10) | 25·25 (8) |
| 28 | 3·50 (9) | 2·50 (9) | 3·25 (11) | 4·75 (9) | 5·25 (8) | 5·75 (2) | 25·00 (9) |
| 219 | 3·50 (9) | 2·50 (9) | 3·75 (5) | 4·75 (9) | 5·00 (10) | 5·50 (4) | 25·00 (9) |
| 206 | 3·75 (7) | 2·75 (8) | 3·50 (9) | 4·50 (11) | 5·50 (6) | 4·50 (11) | 24·50 (11) |

Firstly, it is essential that the results from each field should be examined separately. It is mathematically possible to scale the results from a number of fields to a common moisture content and then to examine them as a whole. This would not be satisfactory. Soil conditions in different fields may vary. The plucking of the bushes in different fields would probably have been carried out over different periods, during which climatic conditions would vary. As with the moisture contents, the results could be scaled to a common rainfall, but this would be quite valueless as it is improbable that there is any definite correlation between crop and rainfall. It is for such reasons as these that results from one field should not be examined against those of another. As far as plant selection work is concerned, scaling of any description is nothing more than a mathematical trick which proves nothing. On the other hand, if the results from each field are examined separately, we have a number of bushes all plucked at the same time, under the same weather conditions, and situated in a more or less unvarying type of soil. In such circumstances the figures are fairly comparable.

Secondly, consideration should not only be given to the highest total yields, but the orders of merit should also be taken into

account. A bush giving a high total yield may quite easily have given the greater part of that yield in one or two plucking periods and then have dropped to a low position in the order of merit at all other plucking periods. The type of bush desired is one which not only gives a high yield, but does so consistently. For instance, bush No. 1 in the above table is not only the highest yielder but is so on four occasions out of six. In its last plucking period it dropped to seventh position but its yield in this period is only three-quarters-of-an ounce less than the highest-yielder in the same period. Its low position in the order of merit can therefore be ignored and, indeed, may be due to an error in weighing, or some similar cause.

Thirdly, a standard should be laid down and all bushes not attaining this standard should at once be rejected, regardless of any other considerations. This standard should be *at least* five times the yield of the field over the period covered by the 48 pluckings. This is of the greatest importance for it guarantees that when the progeny of the mother-tree are ultimately planted out in the field in a replanting programme, the yield of that field will be substantially improved, though of course, the yield of the field cannot be expected to equal that calculated from the mother-tree alone. There would be what one might call an "averaging out" of the yield, due to the influences of the varying environments in which the progeny are grown. For comparison of bush yields with field yields we may assume that a field contains approximately 3,200 bushes per acre, so that an ounce per bush would represent a field equivalent of 200 lb. per acre. For instance, in the given table, bush No. 1 with a yield of 30.25 oz. is giving the equivalent of 6,050 lb. per acre, which is 7½ times the yield per acre (812 lb.) of that field.

Finally, the number of the selections may be limited by such factors as the nursery space available for propagation. In this case it is suggested that selections and rejections should be made at the gaps in the total yields, if such occur. For instance, in the table given, it may be difficult to decide whether to retain bush Number 32 and reject Number 33. The difference between them is only half-an-ounce, which is not sufficiently significant to enable one to say with any certitude that the former is a better bush than the latter. There is, however, a fairly significant gap between the yields of bushes Nos. 1 and 3 and the next in order of merit. We may therefore safely retain the first two bushes and reject the rest. If it is desired to retain more than two bushes we may retain the first six in order of merit, for it will be noticed another fairly significant gap occurs in the yields at this point. The question of how many bushes should be retained for propagation is one of personal choice and it may later be found desirable, for one reason or another, to make use of some of those rejected in the first instance.

The writer makes no claim that the methods adopted by him on Doombagastalawa are either perfect or ideal. Indeed. experience has shown that a great deal of unnecessary work was undertaken, and the following improvements are suggested :—

(a) Let the pruners or pluckers do the preliminary selection, as described above. There is much to be said for both methods, and perhaps the best would be a combination of the two. Pluckers could carry out the preliminary selection just before pruning and their selections tested for actual yield over 8 plucks. Eliminations should be ruthless. The bushes retained can be easily compared for visual characteristics after pruning the rest of the field. At the same time, pruners can be instructed to leave any bushes they consider better than those left by the pluckers,

(b) After a visual comparison of the bushes has been undertaken and rejections made where thought desirable, they should be pruned down, and those retained subjected to actual yield tests as described. It is unnecessary, however, to undertake more than 24 plucks as it is found that relative values are not sufficiently altered by more pluckings as to justify the extra work involved. No time should be lost in measuring bushes, counting primary branches, or any similar plan. Such methods are of doubtful value and a waste of time. It would seem preferable to get straight on to actual yield tests.

(c) Should a number of potential high yielders be lost, either through adopting methods of selection subsequently found to be not the best, or through inability to deal with a large number of bushes at any one time, the following remedy is suggested :—

For the sake of convenience, we will call an 8-round pluck a "plucking period." At the *beginning* of *any* plucking period a number of bushes which appeared to be good yielders, may be added to those already under test. At the end of the plucking period we shall then have yield records of two sets of bushes — those which have been tested over perhaps several plucking periods, and those of the "new entrants." We eliminate the undesired bushes in the first set according to plan. Of the bushes remaining, there will be one which is the lowest yielder. In examining the "new entrants" we eliminate all those whose yields are below that of this lowest yielder, retaining for further test those whose yields are above it. This process can be carried on indefinitely, the lowest yielder of those retained in the original set plus any additions subsequently made, being the criterion for the retention or rejection of the "new entrants." In this way a very large number of bushes can be subjected to actual yield tests without involving very much additional work or subjecting factory accommodation to too great a strain. The objection to this plan is that the records of some bushes finally selected may be incomplete, rendering total yield comparisons useless, but this, is not a serious objection. What is required are the outstanding bushes, and a bush which can gain entry into the circle of the original *elite*, and remain there to the end of the tests, must be worthy of its position, even though its yield records are incomplete. It must be remembered that if selection work is to produce the results desired the search for material must be *thorough.*

(d) Bushes suffering from disease should be rejected. It may be thought that if a bush is a high-yielder in spite of the effects of a disease, probably due to an unhealthy environment, its progeny will certainly be higher-yielders in a more favourable locality where the disease is not prevalent. This is so, but one of the objects to be aimed at in selection work is the selection of mother-trees which are disease resistant, and therefore if it is known that a bush is not disease resistant it should be rejected out of hand.

(e) Moisture contents were recorded for the purpose of scaling described, but this is deemed to be of no value, so the recording of moisture contents may be dispensed with. On Doombagastalawa the moisture content of each plucking period was recorded from a sample of the bulked leaf from all the bags. The moisture contents of individual bushes might vary considerably on either side of that of a bulked sample. To record the moisture content of each bag separately is impracticable as, apart from the time involved, while one bag was being tested the others would rapidly absorb moisture from the surrounding atmosphere.

(f) Results given in terms of dry tea are more accurate than those given by any other means, but it is doubtful if great accuracy in yield determinations is of importance in the early stages of selection work. What is required are *relative* values and these may be expressed more easily in terms of the green leaf weight or flush counts. Yield records in terms of fired tea must again be made later when clones are laid down and the progeny of the selected mother-trees are established under indentical environmental conditions. If time is of no account the recording of yields in terms of fired tea on the lines indicated may be undertaken. On the other hand, it would seem desirable to reach the stage of clonal tests in selection work as rapidly as possible and, for this reason the determination of relative values would be achieved very much more easily and rapidly by either counting pieces of flush, as recommended by Dr. Eden in *The Tea Quarterly* Vol. XIV, Part III (October 1941), or merely weighing the green leaf.

It is proposed to adopt the former method in future tests on Doombagastalawa.

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# MINUTES OF A MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD 28-9-43

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Minutes of a Meeting of the Board of the Tea Research Institute of Ceylon held at the Ceylon Chamber of Commerce Rooms, Colombo, on Tuesday, 28th September, 1943, at 2-30 p.m.

*Present.*—Mr. T. B. Panabokke, Chief Adigar, (Chairman), the Director of Agriculture (Mr. E. Rodrigo, C.C.S.), Major J. W. Oldfield, C.M.G., O.B.E., M.C., Mr. J. C. Kelly, Mr. W. H. Gourlay, Mr. G. K. Newton, Mr. W. P. H. Dias, Mr. H. St. J. Cole-Bowen and Dr. R. V. Norris (Director and Secretary).

Letters expressing inability to attend were received from the Hon'ble the Financial Secretary, the Chairman, Planters' Association of Ceylon and Mr. R. G. Coombe.

(1) Notice convening the meeting was read.

Before proceeding with the business of the meeting the Chairman referred to the recent death of Mr. D. E. Hamilton, a former member of the Board. Mr. Panabokke said Mr. Hamilton had always taken a keen interest in the affairs of the Institute and his services while a member of the Board had been much appreciated. He felt sure the Board would wish to record this appreciation and to send an expression of their sympathy to Mrs. Hamilton.

The motion was unanimously passed in silence.

(2) The Minutes of the Meeting of the Board held on the 14th May, 1943, as

amended by the correction slip issued, were confirmed.

## 3. MEMBERSHIP OF THE BOARD

Reported that the C. E. P. A. had renewed for a further period of three years from the dates of expiry of their present appointments, the nominations of Major Oldfield and Mr. J. C. Kelly as their representatives on the Board.

## 4. FINANCE

*(a) Institute's Accounts to 31st August, 1943.*

(i). *Fixed Deposits.*—Reported that of the sum shewn on fixed deposit Rs. 75,000 had since matured and had been utilised for payment of the sum due on the Government Loan on the 27th September.

(ii). Reported that a further sum of Rs. 25,000 had been placed on fixed deposit so that the full loan payment of Rs. 100,000 due in September, 1944, was now on deposit.

(iii). *Investments.*—Reported that the balance on current account at the end of September was likely to be about Rs. 100,000. This was higher than anticipated owing to heavy receipts from the cess in August.

It was decided to make a further investment of approximately Rs. 40,000, the nature of the investment to be decided by the Chairman and Director in consultation with the Financial Secretary.

(iv). *Estate Working Account.*—It was noted that in view of the exceedingly short crop obtained to date, it was unlikely there would be any profit on estate working account for the year.

*(b) Tea Research Institute Cess 1944-48.*

Reported that the Ceylon Association in London, the Planters' Association of Ceylon and the Ceylon Estates Proprietary Association had all approved of the Board's proposals in regard to the continuation of the cess at 14 cents.

As no reply had yet been received from the Minister for Agriculture to the Institute's application, the Director was instructed to write to the Minister and ask him that, if possible, the matter should come up before the State Council in November.

## 5. ST. COOMBS ESTATE

*(a) Crop.*—Reported that crop to 31st August was 36,542 lb below the figure to same date in 1942, this being chiefly due to the severe drought experienced in the earlier months and very cold and sunless weather later. It was not anticipated the deficiency could be made good in the remaining months of the year.

The Director gave figures for some of the individual monthly yields with corresponding figures for 1942.

*(b) Visiting Agent's Report dated 16th June, 1943.*

*Pruning.*—The recommendation of the Experimental Committee to bring No. 1 Field on to a 3-year programme was approved.

*Liquid Fuel Installation.*—The Board sanctioned expenditure of Rs. 2,200, the estimated sum required for provision of a liquid fuel installation for the 4-ft. drier, the available equipment being unsuitable for this machine.

*Insurances.*—Reported that the Colombo Commercial Co. now advised that insurance cover on the factory buildings should be increased to 200 per cent above pre-war figure. Cover on machinery at 100 per cent above pre-war value was considered adequate for the present.

The Director was instructed to take out the extra cover and to extend the period of indemnity under the Loss of Profits Policy to two years.

He was also asked to impress on the superintendent the need for full training of staff in fire precautions.

*(c) Food Production on St. Coombs.*

Reported that attempts to obtain a share in a syndicate for food production at a more suitable elevation had so far proved unsuccessful. The Experimental Committee recommended in these circumstances that St. Coombs should contract out.

Mr. Newton pointed out that the only waste land at St. Coombs was patana and he was satisfied that this could not be economically developed in food crops at any rate for quick results. Grain crops could not be grown at St. Coombs and he was strongly opposed to the interplanting of root crops in tea as severe damage to the tea resulted with very little return in the way of food.

The Director of Agriculture agreed as to the difficulty of growing food crops at St. Coombs but urged that the Institute should lease a suitable block in a dry zone and open up and develop this area.

Major Oldfield, Mr. Kelly, Mr. Cole-Bowen and Mr. Newton all stressed the difficulties that would arise in such a scheme in regard to labour and supervision.

The Chairman suggested the Government Agent, C.P. might be applied to for a grant of land for chena or paddy cultiva tion

The Director of Agriculture thought a grant of land for paddy cultivation could be obtained under the Colonisation Scheme but admitted the difficulty in regard to labour.

Mr. Cole-Bowen suggested that the Institute as an alternative might meet its obligations under the Ordinance by the purchase of cattle and pigs on a sufficient scale. Cattle would probably have to be stall-fed but he thought the venture would be profitable.

Mr. Dias then informed the meeting that the Rubber Research Scheme was opening up land in the Matugama area and he thought the Institute might be able to come to a working arrangement with the Rubber Research Scheme on the lines of a syndicate.

After further discussion, there was general agreement that the latter proposal offered the most hopeful solution and the Director was instructed to make the necessary enquiries.

Mr. Gourlay urged as a subsidiary measure that the Institute should make further experiments in regard to the development of some of the patana under food crops. Mr. Newton and the Director pointed out that this would have to be considered a relatively long-term problem and was only likely to succeed if the land could be adequately farmed, stock such as pigs, etc. being provided.

Major Oldfield supported Mr. Gourlay. He agreed no immediate results were likely, but he thought a small-scale experiment on the lines suggested would be of value in showing how such land could be improved and developed.

The Board supported the above proposal and the Director said he would place the matter before the Estate and Experimental Sub-Committee.

*(d) Minutes of the Meeting of the Estate and Experimental Sub-Committee held on 18th September, 1943.*

Most of the items had been covered by the items mentioned above. In regard to the question of weeding raised in the Minutes the Director said arrangements were being made for Dr. Eden to visit a number of District Planters' Associations and discuss the points at issue. A further report would then be made.

### 6. SENIOR SCIENTIFIC STAFF

*Director.*—It was noted that the Director became due for home leave in February last. Permission was granted for the Director to take the 21 days' local leave, due to him for 1943 and not yet utilised, in South India in December, combining such leave with the Xmas holidays. Dr. Gadd to act as Director during Dr. Norris' absence.

### 7. JUNIOR SCIENTIFIC STAFF

Reported that Dr. J. G. Shrikhande, Research Assistant, Agricultural Division, had been offered the appointment of Assistant Professor of Sugar Technology, Cawnpore

Confirmation of the offer was subject to the report of the Medical Board before which Dr. Shrikhande had appeared but it was understood this would be favourable. In this case Dr. Shrikhande would shortly be resigning his appointment with the Institute.

The Director said enquiries about suitable candidates likely to be available in Ceylon were being made and proposals for filling the vacancy would be submitted at a later date.

The Board approved of the payment to Dr. Shrikhande on the termination of his appointment, of the balance standing to his credit in the Junior Staff Provident Fund.

It was decided to hold the next meeting of the Board at 3 p.m. on Friday, 26th November, in Colombo, a meeting of the Finance Committee being held in the same afternoon at 2-30 p.m. The estimates for 1944 would be considered at this meeting.

To comply with the Ordinance another meeting would have to be held about the middle of December but business at this was likely to be of a formal nature only.

The meeting then concluded with a vote of thanks to the Chair.

ROLAND V. NORRIS

*Secretary.*

# The Tea Research Institute of Ceylon.

## BOARD OF CONTROL

(A) Representing the Planters' Association of Ceylon:—

(1) Mr. R. G. Coombe

(2) Mr. G. K. Newton

(3) Mr. H. St. J. Cole-Bowen

(B) Representing the Ceylon Estates Proprietary Association:—

(4) Major J. W. Oldfield, C.M.G., O.B.E., M.C.

(5) Mr. J. C. Kelly

(6) Mr. W. H. Gourlay

(C) Representing the Low-Country Products' Association:—

(7) Mr. W. P. H. Dias

(D) Representing the Small-Holders:—

(8) Mr. T. B. Panabokke, First Adigar (Chairman)

(E) Ex-Officio Members:—

(9) The Hon. the Financial Secretary

(10) The Director of Agriculture

(11) The Chairman, Planters' Association of Ceylon

(12) The Chairman, Ceylon Estates Proprietary Association

Secretary, Roland V. Norris, D.Sc., St. Coombs, Talawakelle.

# CONTENTS.




The publications of the Tea Research Institute will be sent, free of charge, to Superintendents of Ceylon tea estates, over 10 acres in extent, and to Estate Agencies dealing with Ceylon tea, if they register their names and addresses with *the Director, Tea Research Institute of Ceylon, St. Coombs, Talawakelle.*

Other persons can obtain the publications of the Institute on application to the Director, the subscription being Rupees fifteen per annum for persons resident in Ceylon or India, and £1-5-0 for those resident elsewhere. Single numbers of *The Tea Quarterly* can be obtained for Rs. 2-50 or 4*s*. In the case of Indian cheques four annas should be added to cover commission.